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Use of Weather Information by General Aviation Pilots, Part I, Quantitative: Reported Use and Value of Providers and Products

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Final Report

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16. Abstract

Data obtained from 221 general aviation (GA) pilots were examined to determine their usage patterns for weather information. Weather products, providers, and en-route information sources were ranked according to relative use and rated by perceived information value, frequency of use, and time invested per usage. The measures were highly correlated. Conclusion #1: A small fraction of pilots show sparse use patterns and these may be at risk for flying with inadequate preparation. Conclusion #2: There seems to be a strong tendency for many pilots to prefer relatively simple forms of information (e.g., METARS). This may present a problem, given the often-complex nature of weather.

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GLOSSARY

ADDS . . . . . Aviation Digital Data Service

AFSS . . . . . . Automated Flight Service Station (a.k.a. FSS)

AIRMET . . . Area Meteorological Forecast

AOPA . . . . . Aircraft Owners and Pilots Association

ATIS . . . . . . Automated Terminal Information System

AWOS . . . . . Automated Weather Observation System

DUATS . . . . Direct User Access Terminal Service

FAA . . . . U.S. Federal Aviation Administration

FA . . . . Aviation area 18-hour forecast

FD . . . . Winds and temperatures aloft

FSS . . . . Flight Service Station (a.k.a. AFSS)

GA . . . . General Aviation

METAR . . . . Meteorological Aeronautical Report

NEXRAD . . Next-Generation Radar (Doppler radar)

NOAA . . . . . National Oceanic and Atmospheric Administration

NWS . . . . . . National Weather Service

PIREPS . . . . Pilot Reports

SIGMET . . . Significant Meteorological Forecast

TAF . . . . Terminal Aerodrome Forecast

TWC . . . . . . The Weather Channel

Contents

USE OF WEATHER INFORMATION BY GENERAL AVIATION PILOTS, PART I, QUANTITATIVE: REPORTED USE AND VALUE OF PROVIDERS AND PRODUCTS

INTRODUCTION

Background and terminology

The causes of aviation accidents are varied and many. Appendix A gives an extensive list (FAA, 2003). However, weather remains a major cause of general aviation fatalities. While weather was cited as causal in only 4% of general aviation (GA) accidents, it accounted for 12 to 17% of fatalities, since about 70% of weather-induced accidents prove fatal (AOPA, 2005). The linear trend lines added to Figure 1 show that the relative involvement of weather in GA accidents and fatalities has remained relatively stable despite considerable effort spent trying to lower it ("fatalities" adj. R^2 = .046, trend line slope = -.47, p = .33, NS).

The U.S. Federal Aviation Administration (FAA) has a stated current goal of reducing GA fatalities (FAA, 2006). To this end, weather-related accidents are targeted for reduction. But the complexity of weather and the corresponding need for pilots to understand the weather situation that may impact any given flight requires effective analysis, summarization, and communication of weather information.

Weather information comes mainly in the form of products and providers. A weather *product* is a relatively

Figure 1. (Lower line) percent of GA accidents involving adverse weather. (Upper line) percent of total fatalities resulting from those accidents (from AOPA's *2004 Nall Report*, derived from U.S. NTSB and FAA data). Dashed lines added to show linear trend.

small package of related information constituting a stand-alone report (e.g., METAR, TAF). Weather *providers* are organizations dedicated to bundling weather products into convenient, user-friendly form. The Automated Flight Service Station (usually known as the Flight Service Station, or FSS) is a good example of a weather provider. Providers try to give pilots a strategic sense of the weather to complement the tactical sense given by the separate weather products themselves. There are many weather providers, most of them commercial, for-profit. High-end providers offer features rivaling those available to airline dispatchers.

The FAA, the National Oceanic and Atmospheric Administration (NOAA), and a number of commercial providers make weather information available in formats designed to aid pilot decision-making. Yet, in many weather-related accidents, investigators found no evidence that the pilot sought out or obtained a weather briefing (Prinzo, Hendrix, & Hendrix, 2007). This raises a normative question – to what extent do GA pilots actually *make use of* the weather services that are available for them?

Latorella, Lane, and Garland (2002) conducted a national survey, which offers baseline insight into these questions. In 1999, they surveyed 97 GA pilots to assess their preferences for weather information products and providers. At that time, the most "important" (most highly rated) individual types of weather information were cloud ceilings, convective weather, lightning, icing, and visibility. The most important weather products were METARs and TAFs. Finally, the most important weather providers were the FSSs and DUATS.

Since that time, informational availability and richness have both grown, particularly as regards the Internet, so the distribution of preferences may have shifted somewhat. Also, Latorella et al. focused on perceived information availability, usefulness, and importance but did not assess the extent of actual usage. Therefore, a follow-on study seemed timely.

Purpose of this research

The purpose of this research was to explore how GA pilots use available weather information. What information actually is available? What do pilots seem to prefer? How much time do they spend in preflight planning for a bad-weather flight? Once aloft, what updates do they acquire, and how much time do they spend acquiring them?
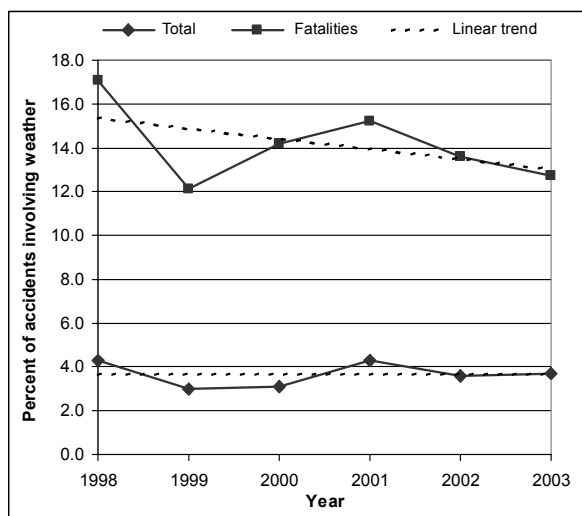
These are relatively straightforward questions. By operationalizing them, gathering data, and analyzing the result, we can identify salient issues worthy of intervention and/or further study.

To address these questions, we interviewed GA pilots concerning their use of weather information products and providers. The intent was to establish actual usage patterns in the field, in contrast to ideal usage patterns as recommended by the FAA.

METHOD

Design and participants

During July and August 2005, we conducted on-site interviews with more than 230 GA pilots at locations across 5 states (CA, OK, ND, IL, FL). Four of the venues were university-based flight schools, the fifth was a helicopter training course. Of these 230 interviews, 221 ultimately provided usable data (the remainder contained large numbers of unanswered questions). Medians were used to express averages when means were artificially elevated by extreme scores. Median pilot age was 23 years (range 18-78), median flight experience was 245 hours (range 15-18,000). Women made up 14% of the sample. All were volunteers paid for their services as subject matter experts.

Procedure

Appendix B gives the full, written-interview protocol. This interview solicited both quantitative and qualitative responses, so both quantitative and qualitative analytical techniques were applied to understand weather usage.

In the qualitative aspect, pilots were asked open-ended questions, plus Likert-scale items designed to assess their thought processes when making decisions about weather. Responses were analyzed according to a coding scheme (rubric). These analyses are addressed in a separate paper titled "Use of weather information by general aviation pilots, Part II, qualitative: Exploring factors involved in weather-related decision making."

The current report focuses on the quantitative aspect. Pilots were asked to (a) rate weather products and providers on the basis of how much they typically used them, (b) assign each a value based on its information content, (c) estimate the percentage of times each was used on a "standard flight," and (d) estimate the number of minutes each was used on such a standard flight, when that item actually was used. A "standard flight" was defined as a 4-hour flight through "weather serious enough to challenge *your* skill level and the aircraft's capabilities."

RESULTS

Weather providers

Table 1 shows how pilots rated the quality of various preflight weather information *providers*. Pilots supplied four ratings, plus one rating arithmetically derived from the last two ratings:

- *Rank* reflected the group's relative rank-ordering of how much pilots felt they used any given weather provider.
- *Value* was a similar measure, reflecting how valuable the group felt that provider's information was.
- *Used on % of Flights* referred to the percentage of flights on which pilots used each provider (answers left blank were coded as 0%).
- *Minutes Spent When Used* referred to the amount of time per flight a given provider was used, if and when it was used.
- *Average Minutes Spent* per flight was the result of multiplying *Used on % of Flights* times *Minutes Spent When Used*. As such, *Average Minutes Spent* was an

Table 1. Normalized ranks, values, frequency of use, and time spent using weather information providers.

Provider	Format	Rank 0-1	Value 0-1	Used on % of flights	Min spent when used	Ave min spent
FSS (standard briefing)	telephone	**1.0**	**1.0**	**61.5**	9.1	5.6
Public NWS or NOAA site	Internet	0.7	0.8	49.8	**13.9**	**6.9**
DUATS	Internet	0.7	0.7	34.0	8.9	3.0
Commercial vendor	Internet	0.4	0.5	28.7	5.0	1.4
The Weather Channel	Internet, TV	0.4	0.5	27.9	7.0	2.0
FSS (outlook)	telephone	0.2	0.3	14.4	2.4	0.3
DUATS	at airport	0.1	0.1	11.3	2.1	0.2
FSS (automated TIBS)	telephone	0.1	0.1	8.9	1.5	0.1
FSS (abbreviated)	telephone	0.1	0.2	9.2	1.8	0.2
Other sources	telephone	0.0	0.0	4.3	0.6	0.0
				Total min spent per flight		19.8

estimate of how much time was spent on a given provider on the "average" flight (even though sometimes it may have been used and sometimes not).
- *Total Minutes Spent Per Flight* was simply the column sum of *Average Minutes Spent Per Flight*, totaled across all providers (19.8 min in this case).

Note that *Rank* could be distinct from *Value*. For instance, we might highly *value* a Rolls-Royce automobile, yet *rank* it low in terms of use, since we cannot afford to actually own one. Similarly, a high-end provider might have high value but be cost-prohibitive or require too much time investment for a private pilot flying for personal reasons.

Ranks and values were equilibrated (normalized) to a scale of 0 to 1.0 to allow for easier comparison of the data across *Rank* and *Value*. Here, "0" represented *least* valuable (or least-used) and "1" represented *most* valuable (or most-used).

Note that the Flight Service Station standard briefing was both ranked and valued highest (1.0) and said to be used on the highest percentage of flights (61.5%). This was closely followed by the public National Weather Service / National Oceanic and Atmospheric Administration / Aviation Digital Data Service (NWS/NOAA/ADDS) Web sites, which actually experienced higher minutes-spent-when-used and overall average minutes used. Internet Direct User Access Terminal (DUATS) also

received high scores across the measures. These findings were largely consistent with Latorella et al., although Internet use had grown much more prominent.

Commercial vendors received intermediate ranks across the board. These were paid services, which probably explained their more modest place among this group of younger pilots. Certainly, the quality of their information was quite high. In fact, much of it came directly from NOAA data feeds.

Finally, a surprising number of pilots reported using The Weather Channel (TWC), even though it was not an FAA-approved source. This was perhaps due to the sheer ease of turning on the television and watching. Also, the Internet-based TWC had a convenient feature allowing the user to type in a zip code and receive easy-to-understand forecasts based on current location. TWC seemed to give pilots something they wanted—a simple report, local and fast. The other sources were far more comprehensive, but that breadth came at the expense of extra time and effort needed to access and understand them.

Weather products

Table 2 shows how pilots rated the quality of preflight weather information *products*. The format is similar to Table 1. These are grouped primarily by *Rank* and *Value*, and they also show reported use. Again, *Rank* and *Value* were normalized so that direct comparisons could be made across those two categories.

Table 2. Normalized ranks, values, frequency of use, and time spent using various weather products.

Product	Format	Rank 0-1	Value 0-1	Used on % of flights	Min spent when used	Ave min spent
METAR	text	1.0	1.0	77.3	4.5	3.4
TAF	text	1.0	1.0	76.5	5.3	4.0
AIRMET / SIGMET	text	0.5	0.7	47.6	3.7	1.8
FA (Aviation area 18-h forecast)	text	0.5	0.5	36.1	3.2	1.2
Charts, Radar (NEXRAD)	graphic	0.5	0.6	44.2	3.6	1.6
ATIS (Automated Terminal Information System)	radio	0.4	0.5	41.4	2.0	0.8
AWOS (Automated Weather Observing System)	radio	0.3	0.4	25.0	1.8	0.5
Charts, Radar summary	graphic	0.3	0.4	23.7	1.7	0.4
FD (Winds and temps aloft)	text	0.3	0.4	30.0	2.2	0.7
PIREP	text	0.3	0.6	36.4	2.2	0.8
ASOS (Automated Surface Observing System)	radio	0.2	0.2	13.0	0.8	0.1
Charts, Prognostication	graphic	0.2	0.3	17.8	1.7	0.3
Charts, Weather depiction	graphic	0.2	0.3	15.1	1.8	0.3
Satellite (images of cloud cover)	graphic	0.2	0.3	20.9	1.8	0.4
Charts, Air- or Surface-analysis	graphic	0.1	0.2	12.8	1.0	0.1
Charts, Convective outlook	graphic	0.1	0.1	10.1	1.1	0.1
GPS (Global Positioning Satellite)	T or G	0.1	0.1	5.1	0.5	0.0
TWEB (Transcribed Weather Broadcast)	radio	0.1	0.1	9.0	0.9	0.1
AC (Severe Wx Outlook Narrative)	text	0.1	0.1	4.7	0.4	0.0
FD	graphic	0.0	0.1	5.3	0.4	0.0
LLWAS (Low Level Wind shear Alerting System)	radio	0.0	0.0	0.9	0.1	0.0
SD (hourly weather reports)	text	0.0	0.0	3.9	0.4	0.0
WW, AWW (weather watch bulletins)	text	0.0	0.0	0.1	0.1	0.0
Other sources		0.0	0.0	0.1	0.0	0.0
					Total min spent per flight	**16.6**

The most highly ranked, valued, and used weather products for this group were METAR and TAF. This was followed, rather distantly, by AIRMET/SIGMET, FAs, and radar charts. Finally, ATIS, AWOS, radar summary charts, FD, and PIREPs showed ratings clustered roughly in third place.

The total estimated average number of minutes per flight spent reviewing weather products was 16.6. This was reasonably consistent with the 19.8 min estimated for providers (the importance of this will be discussed in greater detail later).

En-route sources

Similarly to the previous two tables, Table 3 shows pilot ratings for the quality of *en-route* information sources, again sorted by *Rank*. Two relatively simple sources—ATIS, and AWOS were most highly ranked., Flight Watch, and ASOS were moderately ranked.

Reliability and internal consistency of the data and sample

Reliability is the *sine qua non* of measurement. It means that, if we did the same study again with the same pilots, we should see results highly similar to the original measurement. The standard way of assessing reliability is by test-retest. However, privacy concerns precluded that approach here. So, a number of alternate means were used to assess reliability.

First, we compared the overall time pilots said they spent on weather products (16.6 min) versus on providers (19.8 min). These two numbers should have been similar, and they were. Next, since "providers" consisted of "products plus other services," the time spent on providers should have been slightly greater than that for products, and it was.

Intercategory correlations are a second way of assessing reliability. Where multiple questions are asked about similar things, and respondents give logically consistent answers across categories, it can be assumed that most respondents are answering items thoughtfully rather than randomly. *Rank*, *Value*, *Percent Use*, and *Minutes Used* all measured logically related aspects of value to pilots here. Therefore, they should be strongly intercorrelated as long as participants did not answer randomly.

This was reflected in the results. Table 4 shows the high groupwise category intercorrelations, ranging from .89-.99. All Pearson rs were significant at $p < .01$. This implied that the four measures were logically related. In other words, pilots tended to use information and information sources that they value highly (or vice versa—correlation does not specify exactly what causes what). It also implied that in future studies it is probably unnecessary to use all four measures. *Percent Use* and *Minutes Used* are probably sufficient; both to check reliability and to estimate the total minutes each pilot spends on weather briefings.

Table 3. Normalized ranks, values, frequency of use, and time spent using various enroute weather sources.

Enroute source	Rank 0-1	Value 0-1	Used on % of flights	Min spent when used	Ave min spent
ATIS	**1.0**	**1.0**	**75.6**	**4.6**	**3.5**
AWOS	0.6	0.7	48.7	4.1	2.0
EFAS (FSS Flight Watch)	0.4	0.6	29.1	4.1	1.2
ASOS	0.3	0.4	23.6	1.6	0.4
HIWAS (Hazardous Inflight Weather Advisory System)	0.2	0.3	14.0	1.4	0.2
Avionics	0.1	0.0	8.3	1.2	0.1
TWEB	0.0	0.0	2.6	0.4	0.0
Other sources	0.0	0.0	4.0	0.3	0.0
				Total min spent per flight	**7.3**

Table 4. Provider, product, and enroute source intercorrelations.

	Provider intercorrelations				Product intercorrrelations				Enroute source intercorrelations			
	Rank	Value	%	Min	Rank	Value	%	Min	Rank	Value	%	Min
Rank	1				1				1			
Value	0.993	1			0.975	1			0.979	1		
%	0.988	0.987	1		0.987	0.993	1		0.994	0.961	1	
Min	0.896	0.910	0.902	1	0.954	0.972	0.966	1	0.927	0.960	0.898	1

Table 5. Split-sample within-item correlations.

Rank	Value	%	Min
0.989	0.984	0.984	0.967

A third way to estimate reliability is to randomly split the sample in half to see if each half shows similar scores on the various items. Table 5 shows the Pearson *r*s generated by this process. All correlations were significant at $p < .001$. This implied that, not only was our sample statistically stable, but also that in the future a sample half as large would probably be sufficient, if carefully chosen.

The one thing these reliability estimates did not address was the underlying representativeness of the sample itself. The questions appeared internally consistent and stable, as did the sample itself. But was the actual sample truly representative of all pilots nationwide? That was an important question. Unfortunately, truly random sampling methods were not available for this study due to time, financial, and privacy constraints. These were predominantly student pilots, and we must keep this fact in mind if we wish to generalize these results to pilots at large. On the positive side, these individuals were predominantly (a) far from new to flying and (b) certainly quite representative of the *next generation* of pilots, which is extremely useful for strategic planning purposes.

Variation in weather information use

Table 6 summarizes the estimated average number of minutes these pilots reported spending on bad-weather briefing, using preflight providers, products, and en-route sources. Minimums, maximums, ranges, and bottom 5th and 10th percentiles are shown.

The group means looked acceptable (19.8 min use of preflight providers and 16.6 min for products, plus 7.3 min use of en-route sources). However, the data did point to a small percentage of pilots who focused too little on preparing for, and monitoring, potentially challenging weather. The minimums suggested that a few pilots did very little preflight preparation and nearly no weather monitoring once aloft. Ten percent of pilots reported spending less than 9 min on providers, less than 8.8 min on products, and less than 2.5 min on en-route updates. Five percent reported spending less than 7.1 min on providers, 5.1 on products, and 1.8 on en-route updates.

DISCUSSION AND CONCLUSIONS

The purpose of this research was to try to understand how GA pilots use the weather information available to them. This included documenting what weather sources were currently available, measuring pilot preferences for different providers and products, and assessing what preflight and en-route sources they reported using. Recall that a weather *product* (Table 1) is a small package of related information constituting a stand-alone report. Weather *providers* (Table 2) are organizations dedicated to bundling weather products into user-friendly formats.

For this study, 221 licensed GA pilots were sampled from 5 different instructional venues across the U.S. When asked how they typically prepared for a standard 4-h flight into weather bad enough to challenge their skills and the aircraft's capabilities, these pilots indicated a strong group preference for FSS standard briefings, NOAA/NWS Internet providers and, surprisingly, the Weather Channel.

An important finding here was that many pilots reported preferring relatively simple preflight weather products (METAR, TAF, AIRMET/SIGMET, FA) over more complex, yet informationally richer materials available (e.g., NEXRAD radar images). This has deep implications for the design of future weather products, particularly those on the Internet. Weather is complex by its very nature, and the challenge is to express that complexity in ways simple enough to be useful to the flying public.

These data gave a sense of how the latest generation of pilots appeared to use weather information. On average, these pilots estimated spending 19.8 min with preflight weather providers, 16.6 min with preflight weather products, and 7.3 min with en-route sources. Those averages, alone, might be considered adequate. However, there was considerable variability in the estimates, indicating that inadequate preparation might be anticipated by roughly 10% of pilots. Naturally, "time spent using" was not a perfect proxy for "amount learned," so we must not jump to the hasty conclusion that quantity of use equals quality of use. Nonetheless, even with that caveat, these data probably point to an identifiable group in need of attention.

Table 6. Estimated average min spent on weather briefings by providers, products, and enroute sources.

	Providers	Products	En-route
Average time spent	19.8	16.6	7.3
Minimum	**3.10**	**3.97**	**0.99**
Maximum	138.5	154.6	92.0
Range	135.4	150.6	91.0
Bottom 10th percentile	9.0	8.8	2.5
Bottom 5th percentile	7.1	5.1	1.8

To summarize, Conclusion #1 is that, despite the acceptable group averages on preflight and in-flight attention to weather, *there seemed to be individuals spending as little as 3-4 min on preflight weather briefing and less than one minute on updates, once airborne*. The lowest 10% of pilots reported spending less than 9 min on preflight adverse-weather briefing and less than 2.5 min on enroute updates.

Conclusion #2 is that, while many pilots seem to value and use modern, sophisticated weather information providers, *there seems to be a strong, counter-tendency to value and use that which is simplest, even if simplicity comes at the cost of greater risk*. The most popular weather information products and en-route sources sampled here seemed to be among the simplest (e.g., METARs and TAFs). This has serious implications for user interface design, certification, and training.

It also may reflect a problem for some pilots, given the inherently complex nature of weather. While complex weather information may be available, it is not always what is sought out or understood. From a human factors perspective, there is a lesson for information system design in this: Weather information needs to be

• convenient
• comprehensive, and
• simple to understand,

or there will be some pilots who either fail to acquire it or fail to understand it.

Unfortunately, these 3 points are in competition. That which is convenient tends not to be comprehensive. That which is comprehensive can be difficult to understand. Therein lies a major challenge for the future.

A second challenge lies in the complexity of the way weather factors interact with each other and the flight situation. Knecht, Shappell, and Harris (2005) demonstrated significant visibility x cloud ceiling interaction in GA pilots' decisions whether or not to take off into marginal VFR weather. Driskill, Weissmuller, Quebe, Hand, and Hunter (1997) also noted interactions between visibility, ceiling, precipitation, and terrain. In other words, the challenge is not merely to identify a static set of "most significant weather factors." The problem is more complex than that. Specific circumstances matter (including factors like terrain, aircraft type, time of day, and so forth). Weather provokes both "go/no-go" decisions and "continue/hold/divert" decisions, and the values of specific factors interact in determining the most appropriate decision. So a list of "most-important weather factors" undoubtedly shifts, given the unique circumstances of each flight. In the present study, our results apply to a "typical" 4-hour flight into anticipated-but-unspecified bad weather. Had we set up a different scenario, we might assume the dynamics of decision-making would shift somewhat with the specified circumstances.

These findings are directly comparable to, and extend, Latorella et al.'s survey of GA pilot weather use in 1999. Both that study and the present research indicate that ceilings, convective weather, lightning, icing, and visibility remain prominent as primary information of concern to airmen. FSS also remains a versatile, popular weather information provider. DUATS is still highly valued and used, though it may have lost ground to NOAA/NWS Internet services. Finally, METARs and TAFs were popular weather products then, and are still at the top of the list now.

The Internet is clearly gaining ground. While Internet weather information has become more available, sophisticated, and used in the 6 years between these samples, the *raw information* most GA pilots want to know appears to have largely stayed the same. Given recent investments in improving weather information quality and availability, it is surprising that longstanding sources such as METAR and TAF were rated so highly by users. This may parallel The Weather Channel's popularity in a tendency for users to want brevity and simplicity in summaries of weather information. This preference for simple weather products may belie the apparent "techno-savvy" of the next generation of pilots. In actuality, there may still be a relative lack of sophistication regarding the particular information they are retrieving, understanding, and using. Weather is complex, and all presentations of it are simplifications in some fashion. So how do we present the essentials without overwhelming the user? This is a major challenge for all of us concerned with keeping the blue side up.

Suggestions for further study

In future studies, it is recommended that fewer polling variables are needed (specifically, *Frequency of Use* and *Average Minutes Spent Using* are probably sufficient). Future sample sizes probably do not need to exceed 100 pilots, provided that care is given to sampling both diverse geographic areas and pilot occupations. New studies should also consider validating survey instruments with standard test-retest reliability methods. Flight duration could be explored as an independent variable. Certainly, the sub-group of "low-use" and "simple-information-use" pilots described here may constitute an at-risk group worth investigating. Finally, the possible utility of low-cost, PC-based weather training comes to mind, as well as the similar utility of low-cost, hand-held weather information devices.

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APPENDIX A

List of proposed causal factors for weather-related GA accidents

	ENVIRONMENT FACTORS
PERSONAL FACTORS	Visibility marginal (< 5 miles)
< 100 h in type	Destination visibility < 1 mile
Unfamiliar destination	Ceilings < 3,000' AGL
Fatigue (less than normal sleep prior night)	Destination ceilings < 1,000' AGL
Flight after end of work day	Convective activity within 20 NM of flight
Scheduled commitment after flight	No de-icing equipment surface temperatures < 40°F and clouds or
Recent death of close family member	precipitation
Major domestic problems	Icing forecast (AIRMET more than light) at altitude required to fly with
Illness in family	de-icing equipment
No second pilot who is rated and current	Convective activity w no storm scope or other detection capability
Alcohol within the last 24 hours	Destination dew point spread < 3°
Taking over-the-counter medication	No operational control tower at destination
Inadequate food prior to flight	No VASI/PAPI at destination
Inadequate water prior to flight/ no water on board	No radar environment at destination
Day > 10,000' with no supplemental oxygen	Mountainous terrain
Night > 5,000' with no supplemental oxygen	Approach/departure over water
Flight duration more than 3 hours	High bird hazard
	Unpaved runway
OPERATIONAL FACTORS	IFR and only approach is non-precision
Fuel calculation and reserves incomplete for day/night conditions	Crosswind in excess of 90% demonstrated maximum crosswind in Pilot Operating Handbook
Weight & balance calculation not made	No weather reporting at airport
Weight within 10% max. gross	Precipitation causing obstruction to visibility
Takeoff or landing distance more than 50% of intended runways to be used	No use of flight following or radar advisories in high density traffic areas
Source: Adapted from Federal Aviation Administration. (2003). FAA/Industry Training Standards personal and weather risk assessment guide.	Wet runway
	Ice on runway
	No IFR Flight plan in VFR conditions

APPENDIX B
Interview instrument used in this study

SME#

1. Age____
2. Gender (male __, female __)
3. Primary occupation _____
4. Other current occupation(s)_____
5. Past occupations(s) related to aviation_____
6. Certificates and ratings (check each that applies)

|	Sport		Airplane Single-Engine
	Recreational		Airplane Multiengine
	Private		Rotorcraft
	Commercial		Balloon
	ATP		Airship
	Instrument		Glider
	Flight Instructor		Powered-Lift

7. Type of flying you do (to the nearest 10 percent, for example, recreational 20%)
    recreational____   business____   corporate____   commercial____(these should add to 100%)

    For questions below, "general aviation" (GA) means "any small aircraft not flying for hire."
8. Your total GA flight hours (best guess) _____ Total hours in last 90 days_____

9. Do you own your own GA aircraft, either by yourself or as a member of a partnership? (Y / N)

10. Type(s) of GA aircraft usually flown:_____

11. Your normal personal minimum for GA VFR visibility   _____ statute miles

12. Your normal personal minimum for GA VFR cloud ceiling   _____ feet AGL

    For questions below, if you're not a U.S. citizen, use "country" instead of "state"

13. Current home state (legal residence) _____
14. Approximate percentage of time you've flown GA in your home state _____% versus outside your home state _____% (estimate—should add up to 100%)

15. State(s) where you received GA pilot training_____
16. States where you've flown GA (put a check mark ✔ in each state name below)
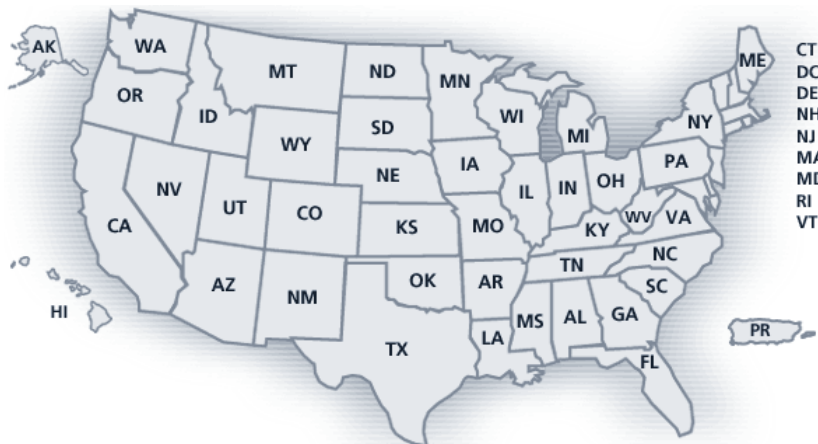
If your flying has been largely outside of the USA, please list below the countries in which you regularly fly and the percentages of time spent in each (estimates)

Country	% time

This is a study about how GA pilots use weather information. Please bear in mind these things:

A. We already know the "textbook answers" for how pilots are *supposed* to use weather information. What we need to know is how real pilots are using real weather information in the real world.

B. Your responses are strictly anonymous and confidential.

C. In the next section we'll refer to "cross-country flights." That may mean different things to different people. So define "cross-country" as: 1) *Non-local* airport, far enough away that the weather could surprise you.

D. "Bad" weather can also mean different things. So define it as: Weather serious enough to challenge *your* skill level and the aircraft's capabilities.

SECTION TWO: CROSS-COUNTRY, BAD WEATHER GA FLIGHT

17. This question will ask details about how you get a PREFLIGHT weather briefing for CROSS-COUNTRY, GA FLIGHT when you ANTICIPATE BAD WEATHER. Use the definitions of "cross country" and "bad weather" from above in forming your responses.

    a. When do you start planning such a flight? (for example, the day before, the morning of, etc.)

    b. Where do you start researching the weather? (e.g., at home? At the airfield?)

        (Below, a weather "product" is a single report like a METAR, TAF, ASOS, or AWOS. A "provider" is an organization like the FSS that bundles individual products together to give a comprehensive wx outlook)

    c. List the main weather information provider(s) you consult. List the main products you use from each provider. What relative importance do you give to these products? (write "1" by the most important product, "2" by the second-most important product, etc.

    d. About how many minutes does usually it take to finalize your bad-weather GA plan?_____

    e. List the major weather factors that would immediately trigger a no-go decision before takeoff.

    f. What weather factors would lead you to divert a flight in progress?

g. Is there any time you anticipated bad weather but took off without planning for it? If so, describe it briefly. Remember—this is 100% anonymous, so do NOT name names of individuals involved.

h. Have social or business pressures ever influenced your GA go/no-go weather decision? (For example, have you ever made a risky flight on a dare, or has a boss ever pressured you into flying against your better judgment?). If so, describe it, taking care not to name names.

i. In plain words, describe what goes through your mind in planning for bad-weather, cross-country GA flight.

j. Briefly, how does your good-weather planning differ from your bad-weather planning?

k. If there were one thing you'd like to see improved about weather information, what would it be?

(As before, a "product" is a single report. A "provider" combines products to give a big picture)

18. Evaluate the top 5 *preflight* weather *providers* you use most to plan a *cross-country, bad-weather* flight.

     a. Rank: Using the 1-to-5 scale below, rank **ONLY** your **5 most-used** providers (**leave others blank**).

1	2	3	4	5
most-used	above average	average	below average	least-used

     b. Value: Using the 1-to-5 scale below, rate the information value of each of those top 5 choices.

1	2	3	4	5
excellent	above average	average	below average	poor

     c. %: Estimate the percentage of cross-country, bad-wx flights you use each of these top 5 providers on. (NOTE: In 18c, 19c, and 20c, the percentages do NOT have to add up to 100%)

     d. Minutes: Estimate the average number of minutes spent on each of the 5 during bad-wx preflight.

Rank	Value	Provider	Format	Details	% of flights	Minutes
1-5	1-5				used on	spent
		Commercial vendor	Internet	Wx via internet, paid (Which site?_____)		
		Public NWS or NOAA site	Internet	Wx via internet, free (Site(s)? _____)		
		DUATS	Internet	FAA Direct User Access Terminal		
		DUATS	at airport			
		FSS	telephone	Flight Service Station, automated briefing (TIBS)		
		FSS	telephone	FSS standard briefing		
		FSS	telephone	FSS, abbreviated briefing		
		FSS	telephone	FSS, outlook briefing		
		The Weather Channel	Internet,TV	Cable TV weather		
		Other sources		List_____		

19. The same way you did in Q18, evaluate the top 8 preflight weather _products_ you use most in planning a cross-country, bad-wx flight. "Text" format means sources you read yourself or that are read to you.
    a. Rank **ONLY** your **8 most-used** products. Write "1" next to the source you <u>use most</u>, etc.
    b. Rate the <u>value</u> each of these 8 using the 1-5 scale of Q18b, for its <u>information value</u>.
    c. Estimate the <u>percentage</u> of cross-country, bad-wx flights during which you used each of the 8.
    d. Estimate the average <u>number of minutes</u> spent on each of the 8 during bad-wx preflight.

Rank	Value	Product	Format	Details	% of flights	Minutes
1-8	1-5				used on	spent
		AC	text	Severe Wx Outlook Narrative (2-day convective outlook)		
		AIRMET / SIGMET	text	Icing, turbulence, IFR, convective advisories, watches		
		ASOS	radio	Automated Surface Observing System		
		ATIS	radio	Automated Terminal Information Service		
		AWOS	radio	Automated Weather Observing System		
		charts, Air- or Surface-analysis	graphic	Constant-pressure (isobar) charts		
		charts, Convective outlook	graphic	48-hr forecast charts for T-storm activity		
		charts, Prog.	graphic	12, 24-hr prognostication charts w. isobars, wx symbols		
		charts, Radar (NEXRAD)	graphic	Doppler radar maps		
		charts, Radar summary	graphic	Maps of precipitation regions		
		charts, Weather depiction	graphic	Maps with isobars, precip, IFR regions, ceilings		
		FA	text	Aviation area 18-hr forecast		
		FD	text	Winds and temps. aloft 12-hr forecast charts		
		FD	graphic	Winds and temps. aloft 12-hr forecast charts		
		GPS	T or G	Global positioning satellite		
		LLWAS	radio	Low-Level Wind Shear Alert System (at airports)		
		METAR	text	Meteorological Aviation Routine		
		PIREP	text	Pilot reports		
		Satellite	graphic	Satellite photos of cloud cover		
		SD	text	Radar weather reports (hourly)		
		TAF	text	Terminal Aerodrome Forecast		
		TWEB	text	Transcribed Weather Broadcast (over telephone)		
		WW, AWW	text	Weather Watch bulletins, severe		
		Other sources		List_____		

20. The same way you did in Q18, evaluate the top 3 _en route_ weather sources you use most during a cross-country, bad-weather flight (here, a "source" can _either_ be a product _or_ a provider).
    a. <u>Rank</u>: Rank **ONLY** your **3 most-used** sources. Write "1" next to the source you <u>use most</u>, etc.
    b. <u>Value</u>: Using the 1-5 scale of Q18b, how do you rate each of these 3 source's information value?
    c. <u>%</u>: Estimate the <u>percentage</u> of cross-country, bad-weather flights you use these 3 sources on.
    d. <u>Minutes</u>: Estimate the average <u>number of minutes</u> you spend on each during bad-wx flight.

Rank	Value	Source	Details	% of flights	Minutes
1-3	1-5			used on	spent
		avionics	(e.g. on-board radar, Stormscope, etc) List_____		
		ASOS	Automated Surface Observing System		
		ATIS	Automated Terminal Information Service		
		AWOS	Automated Weather Observing System		
		EFAS	Enroute Flight Advisory System (Flight Watch through FSS)		
		HIWAS	Hazardous Inflight Weather Advisory System (selected VORs)		
		TWEB	Transcribed Weather Broadcast (over VOR, NDB)		
		Other sources	List_____		

21. Are there reasons why the preflight and enroute sources you USE most aren't the ones you VALUE most? If so, why? (For example, some of the graphic Internet products download slowly on a modem. Or some products may be unavailable. Or you might consider some too incomplete or unreliable).

22. What percentage of FSS briefers do you think are National Weather Service-certified? (best guess) _____

23. What percentage do you think are pilots? _____

24. Would it matter to you if your briefer were not a pilot, as long as he/she were NWS-certified? (circle answer)

1	2	3	4	5
not at all	a little bit	somewhat	quite a bit	an extreme amount

25. If you use FSS weather briefings, how satisfied are you with them? (leave blank if you don't use FSS)

1	2	3	4	5
not at all	a little bit	somewhat	quite satisfied	extremely satisfied

26. What is the <u>typical</u> number of weather reporting stations (e.g. KOKC, KDWF) you check before an average 4-hour, bad-weather GA flight?____   The <u>smallest</u> number?_____   The <u>largest</u> number?_____

Regarding VFR LOCAL FLIGHT, what percentage of the time do you do the following (0-100%)?

27. I get a briefing on the weather before I take off   ____

28. I request weather updates during flight   ____

Regarding VFR CROSS-COUNTRY FLIGHT, what percentage of the time do you do the following?

29. I get a briefing on the weather before I take off   ____

30. I request weather updates for route & destination during flight   ____

Answer questions 31 through 34 using a scale of "0" through "6 or more": How many times have you …

31. become so disoriented that you had to land or call ATC for assistance in determining your location?   ____

32. flown into areas of IMC without an instrument rating or an instrument-qualified aircraft? ……….   ____

33. become so disoriented after entering IMC that you had difficulty in maintaining aircraft control?   ____

34. turned back or diverted to another airport because of bad weather while on a VFR flight? ………..   ____

Use the scale below to answer Qs 35-38

1	2	3	4	5
not at all	a little bit	somewhat	quite a bit	an extreme amount

35. How much does the <u>distance you have to fly through bad weather</u> affect your willingness to fly?   ____

36. Does having *non-family* passengers affect your willingness to fly in bad weather?………………..   ____

37. Does having *family* passengers affect your willingness to fly in bad weather? ……………………   ____

38. Has social or corporate pressure ever affected your willingness to fly in bad weather? ……………   ____

39. Have you ever had a life-threatening flight experience related to weather? (Y / N) ……………….   ____
    (On Q 39, if answer is 3, 4, or 5, please briefly describe your experiences).

THIS CONCLUDES THE SUBJECT MATTER EXPERT INTERVIEW. THANKS AGAIN.